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The photographs up to and including the first on March 11 were taken with the reflector, the remainder with the Astrographic telescope. From January 28 to February 17 one exposure, and from February 18 to March 16 two exposures were given on each plate. Fuller details of these observations will be given in the Greenwich volume for 1904.

On the Astronomical Observations recorded in the "Nihongi," the ancient Chronicle of Japan. By E. B. Knobel.

Our knowledge of the *Nihongi*, which is the standard native history of ancient Japan, is derived from the translation made by Mr. W. G. Aston, which was published by the Japan Society a few years ago.

The *Nihongi* purports to be a history of Japan from the earliest mythological times to the year A.D. 697.

It contains the record of several astronomical observations, which are not without interest.

The observations consist of records of "Eclipses of the Sun and Moon," "Occultations of Stars and Planets," "Conjunction of Planets," "Apparition of Comets and Meteors," and two observations apparently of the Aurora Borealis.

The period covered by these observations is from the year A.D. 620 to 696.

The chronology of the earlier part of the *Nihongi* has been shown by several authorities to be entirely unreliable, and indeed Bramsen does not hesitate to assert that the fictitious dates therein ascribed to events, constitute one of the greatest literary frauds ever perpetrated. Though the above remark applies more particularly to chronicles before A.D. 600, it is of importance to critically examine the dates given to the astronomical events.

This is attended with some difficulty on account of the complicated chronological system in use in Japan, and which was borrowed entirely from China.

The elements of Japanese chronology are succinctly described by Mr. Kinoshita in his interesting little book, *Ancien Japon*, and also by the late Mr. Williams, the former assistant-secretary of the Royal Astronomical Society, in his work on "Chinese Observations of Comets"; but for the precise reconciliation of dates, the *Japanese Chronological Tables* of Bramsen, published at Tokio in 1880, though they go no further back than A.D. 645, are quite indispensable.

The year was a lunar year, consisting of twelve months of twenty-nine or thirty days; but in order to establish some correspondence between the months and the seasons, an additional month was intercalated every thirty-three months, or seven intercalary months in the lunar cycle of nineteen years. Common years had therefore 354 days, and embolismic years 383 or 384 days. The rules for determining the date of an intercalary

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month are too complicated to be given here; but roughly, when the discrepancy between the civil and the solar years exceeds half a month, a correction is necessary, and an intercalary month is made. The months were designated by their ordinal numbers, but the intercalary month received the ordinal number of the preceding month. It is thus obvious that there is here a great possibility of error in reducing a date in Japanese or Chinese records to European chronology.

On this point the sexagenary cycle of years, of months, and of days, instituted by the Chinese in very ancient times, and continued by them and the Japanese to the present day, affords a means of checking dates with considerable certainty.

The commencement of the year was never coincident with January 1, but ranged from January 20 to February 18; the fact being that the year began with the new moon following the first new moon after the winter solstice.

The sexagenary cycle was formed by the combination of one series of twelve signs, named after the signs of the zodiac, called in Japanese Ju-ni-shi, and a second series of ten signs called Jikkan.

Sexagenary Table.

1.	甲 子	21.	甲 申	41.	甲 辰
2.	乙 丑	22.	乙 酉	42.	乙 巳
3.	丙 寅	23.	丙 戌	43.	丙 午
4.	丁 卯	24.	丁 亥	44.	丁 未
5.	戊 辰	25.	戊 子	45.	戊 申
6.	己 巳	26.	己 丑	46.	己 酉
7.	庚 牛	27.	庚 寅	47.	庚 戌
8.	辛 未	28.	辛 卯	48.	辛 亥
9.	壬 申	29.	壬 辰	49.	壬 子
10.	癸 酉	30.	癸 巳	50.	癸 丑
11.	甲 戌	31.	甲 午	51.	甲 寅
12.	乙 亥	32.	乙 未	52.	乙 卯
13.	丙 子	33.	丙 申	53.	丙 辰
14.	丁 丑	34.	丁 酉	54.	丁 巳
15.	戊 寅	35.	戊 戌	55.	戊 午
16.	己 卯	36.	己 亥	56.	己 未
17.	庚 辰	37.	庚 子	57.	庚 申
18.	辛 巳	38.	辛 丑	58.	辛 酉
19.	壬 午	39.	壬 寅	59.	壬 戌
20.	癸 未	40.	癸 卯	60.	癸 亥*

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* It is preferable to use the Chinese characters rather than the words in Roman letters, on account of variations in orthography.

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Months and days, like years, are counted by sexagenary cycles independently of each other.*

The Japanese call, under this system, the designation in the cycle the E-to † of the year, or month, or day. Intercalary months have no E-to. The E-to of the months for the Ju-ni-shi sign is always as follows :—

1st month	Tora	寅	7th month	Saru	申
2nd ,,	U	卯	8th ,,	Tori	酉
3rd ,,	Tatsu	辰	9th ,,	Inu	戌
4th ,,	Mi	巳	10th ,,	I	亥
5th ,,	Muma	午	11th ,,	Ne	子
6th ,,	Hitsuji	未	12th ,,	Ushi	丑

The following table from Bramsen's work may be useful :—

Perpetual Table showing the E-to of any Japanese Month.	If the Year from Jimmu-Tenno, B.C. 660, or the corresponding European Year, ends in				
	1 or 6.	2 or 7.	3 or 8.	4 or 9.	5 or 0.
1st month	27	39	51	3	15
2nd ,,	28	40	52	4	16
3rd ,,	29	41	53	5	17
4th ,,	30	42	54	6	18
5th ,,	31	43	55	7	19
6th ,,	32	44	56	8	20
7th ,,	33	45	57	9	21
8th ,,	34	46	58	10	22
9th ,,	35	47	59	11	23
10th ,,	36	48	60	12	24
11th ,,	37	49	1	13	25
12th ,,	38	50	2	14	26

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* The Chinese sexagenary cycle of years was included by Ulug Beigh in his Samarcand Tables, 1437, and will be found also in the valuable chronological tables given by Johannes Gravius at the end of his *Epochæ Celebriores Ulug Beigi*, 1650.

† The name E-to is derived from the fact that the terminations of the Japanese names of the ten signs of Jikkan are alternately -e and -to, thus: Kinoe, Kinoto, Hinoe, Hinoto, &c.

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The following are the astronomical records in order of subject :—

Eclipses of the Sun.

1. "36th year of Emperor Suiko, A.D. 628, spring, 3rd month, 2nd day. There was a total eclipse of the Sun."

The first day of the first month was February 10, and the second day of the third month was April 10. Oppolzer, in his *Canon der Finsternisse*, gives a total eclipse of the Sun, with the central line running through Japan, on April 10, 0^h $49^m{\cdot}7$ G.M.T.

2. "8th year of Emperor Jomei, A.D. 636, spring, 1st month, 1st day. There was an eclipse of the Sun."

The first day of the first month was February 12. There is no eclipse in Oppolzer's table which can possibly accord with this date.

3. "9th year of Emperor Jomei, A.D. 637, spring, 3rd month, 2nd day. There was an eclipse of the Sun."

The first day of the first month was February 1. The second day of the third month was April 2. Oppolzer gives a total eclipse of the Sun, with the central line running through Japan, April 1, 0^h 3^m G.M.T.—a discrepancy of one day.

4. "9th year of Emperor Temmu, A.D. 680, winter, 11th month, 1st day. There was an eclipse of the Sun."

The Shūkai quotes a statement that this eclipse was of 9½ tenths, or nearly total." The first day of the eleventh month was November 27. Oppolzer's table gives an annular eclipse of the Sun, with the central line passing through Japan, on November 27, 3^h $13^m{\cdot}4$ G.M.T.

5. "10th year of Emperor Temmu, A.D. 681, winter, 10th month, 1st day. There was an eclipse of the Sun."

The first day of the tenth month was November 16. Oppolzer's table shows an annular eclipse of the Sun, with the central line passing through Southern China, on November 16, 2^h 24^m G.M.T.

6. "5th year of Emperor Jitō, A.D. 691, winter, 10th month, 1st day. There was an eclipse of the Sun."

The first day of the tenth month was October 27. Oppolzer's table gives an annular eclipse of the Sun, visible in Japan, October 27, 3^h $1^m{\cdot}9$ G.M.T.

7. "7th year of Emperor Jitō, A.D. 693, 3rd month, 1st day. There was an eclipse of the Sun."

The first day of the third month was April 11. Oppolzer gives an annular eclipse of the Sun April 11, 10^h 44^m G.M.T., visible only as a partial eclipse in Japan.

8. "7th year of Emperor Jitō, A.D. 693, 9th month, 1st day. There was an eclipse of the Sun."

The first day of the ninth month was October 5. Oppolzer gives a total eclipse of the Sun, with the central line running through South China, on October 5, 8^h $2^m{\cdot}1$ G.M.T.

9. "8th year of Emperor Jitō, A.D. 694, 3rd month, 1st day. There was an eclipse of the Sun."

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The first day of the third month was March 31. Oppolzer gives a partial eclipse of the Sun March 31, $11^h\ 19^{m}\cdot7$ G.M.T.

10. "8th year of Emperor Jitō, A.D. 694, 9th month, 1st day. There was an eclipse of the Sun."

The first day of the ninth month was September 25. Oppolzer gives a partial eclipse of the Sun, September 24, $22^h\ 47^{m}\cdot3$ G.M.T. The correction for longitude makes the *Nihongi* date correct.

11. "10th year of Emperor Jitō, A.D. 696, autumn, 7th month, 1st day. There was an eclipse of the Sun."

The first day of the seventh month was August 4. Oppolzer gives an annular eclipse of the Sun, which could only be visible as a partial eclipse in Japan, August 3, $17^h\ 13^{m}\cdot6$ G.M.T. Here, again, the difference of longitude makes the *Nihongi* date correct.

Eclipses of the Moon.

1. "2nd year of the Emperor Kōgyoku, A.D. 643, 5th month, 16th day. There was an eclipse of the Moon."

The sixteenth day of the fifth month was June 8. In Oppolzer's table we find an eclipse of the Moon on June 7, $23^h\ 7^m$ G.M.T., which corrected for longitude agrees with the *Nihongi*.

2. "9th year of the Emperor Temmu, A.D. 680, 11th month, 16th day. There was an eclipse of the Moon."

The sixteenth day of the eleventh month was December 12. Oppolzer gives an eclipse of the Moon December 11, $14^h\ 8^m$ G.M.T., and the *Nihongi* date is correct.

Occultations.

1. "12th year of Emperor Jomei, A.D. 640, spring, 2nd month, 7th day. A star entered the Moon."

The seventh day of the second month is March 6.

2. "1st year of Emperor Kōgyoku, A.D. 642, autumn, 7th month, 9th day. A guest-star entered the Moon."

The ninth day of the seventh month is August 10.

3. "10th year of Emperor Temmu, A.D. 681, 9th month, 17th day. The planet *Mars* entered the Moon."

The seventeenth day of the ninth month is November 3.

Conjunction of Planets.

"6th year of Emperor Jitō, A.D. 692, autumn, 7th month, 28th day. On this night *Mars* and *Jupiter* approached and receded from one another four times in the room of one pace, alternately shining and disappearing."

The twenty-eighth day of the seventh month was September 14.*

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* Very close conjunctions of *Mars* and *Jupiter* are recorded, A.D. 498, 509, 1170, 1591.

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Comets.

"6th year of Emperor Jomei, A.D. 634, autumn, 8th month. A long star was seen in the south. The people of that time called it a besom-star. Hahaki-boshi or Hōki-boshi is the present name for a comet."

The eighth month began August 30. In Williams's *Comets observed in China* a comet is described in *Ma-twan-lin* as being seen, A.D. 634 September 22, in the constellation *Aquarius*, and which on October 3 was no longer visible.

"7th year of Emperor Jomei, A.D. 635, spring, 1st month. The besom-star went round and was seen in the East."

The date of the first day of the first month is January 24. This implies the reappearance of the 634 comet. It is not mentioned in the Chinese annals.

"11th year of Emperor Jomei, A.D. 639, 1st month, 26th day. A long star appeared in the north-west. Priest Bin said it was a besom-star. When it appeared there was famine."

The twenty-sixth day of the first month is March 6. The Chinese *Ma-twan-lin* records a comet, A.D. 639 April 30, as being seen in *Taurus*. Another Chinese chronicle makes the year 638, but neither is reconcilable with the *Nihongi*.

"5th year of Emperor Temmu, A.D. 676, autumn, 7th month. A star appeared in the East seven or eight feet in length. In the 9th month it at length disappeared from the sky."

The seventh month began August 15, and the ninth month October 13. Williams records from the Chinese annals that, A.D. 676, seventh moon, day Ting Hae = July 7, a comet was seen in *Gemini*. It was about three cubits in length. Its luminous envelope increased until it became thirty cubits in length. In the ninth moon, day Yih Yew = September 3, it disappeared. Clearly the same comet is referred to in both chronicles, and it is not improbable that the *Nihongi* account was copied from the Chinese. The discrepancy in the reduction of the date is due to Mr. Williams not having reckoned that the year 676 had an intercalary month, the first day of which was March 20.*

"10th year of Emperor Temmu, A.D. 681, 9th month, 16th day. A comet appeared."

The date is November 2. Probably taken from the Chinese, where it appeared, according to Williams, 681, ninth moon, day Ping Shin = October 17. The discrepancy is due to there being an intercalary month this year, which began August 20, and which Williams did not take into account.

"13th year of Temmu, A.D. 684, autumn, 7th month, 23rd day. A comet appeared in the north-west more than ten feet long."

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* Some particulars of this comet are given by Sherburne in his work on *Manilius*, 1675. He states that it appeared in August, and lasted three months.

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The 23rd day of the seventh month was September 7, there having been an intercalary month this year, the first day of which was May 20. The Chinese record, given by Williams, states: "In the epoch Wan Ming, 1st year, 7th moon, day Sin Wei, there was a comet in the West. It was about ten cubits in length. In the 8th moon, day Kea Shin, it disappeared." From this Williams gives 684 July 8 as the date when the comet was seen, and August 10 as the date of its disappearance. He further remarks that Biot makes the dates September 6 and October 9, but by computation it comes out as he has rendered it. There can be no doubt that this is Halley's Comet. The perihelion passage, according to Hind, was A.D. 684·80, which gives the date September 18.

It is impossible to reconcile Williams's dates for this comet. There can be little doubt, from the Chinese and Japanese descriptions, that the same comet is referred to. A.D. 684 was the first year of the lunar cycle, and it was embolistic. The intercalary moon began on May 20, and it followed the fourth moon of the year; consequently the seventh moon of the chronicle was actually the eighth moon of the year. I append the dates of the first day of each month in the year in question:—

1st month, 1st day	... January 23
2nd „ „	... February 21
3rd „ „	... March 22
4th „ „	... April 20
Intercalary 4th month, 1st day	... May 20
5th month, 1st day	... June 18
6th „ „	... July 18
7th „ „	... August 16
8th „ „	... September 15
9th „ „	... October 14
10th „ „	... November 13
11th „ „	... December 12
12th „ „	... January 11 (685)

Meteors.

"9th year of Emperor Jomei, A.D. 637, spring, 2nd month, 23rd day. A great star floated from East to West, and there was a noise like that of thunder. The people of that day said it was the sound of the falling star."

The date is A.D. 637 March 24.

"3rd year of Emperor Tenchi, A.D. 664, 3rd month. There was a star which fell north of the capital."

The date is A.D. 664 April.

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"11th year of Emperor Temmu, A.D. 682, 8th month, 3rd day. On this evening, at twilight, a great star passed from the East to the West."

The date is A.D. 682 September 10.

"13th year of Emperor Temmu, A.D. 684, 11th month, 23rd day. At sunset a star fell in the quarter of the east as large as a jar. At the hour of the Dog (*id est* 7 to 9 P.M.) the constellations were wholly disordered and stars fell like rain. During this month there was a star which shot up in the zenith and proceeded along with the *Pleiades* until the end of the month, when it disappeared."

This would seem to be a comet. The date is A.D. 685 January 3.

Aurora Borealis.

"28th year of Emperor Suiko, A.D. 620, 12th month, 1st day. There was a red appearance in the sky, over a rod in length, and resembling the tail of a fowl in shape."

Date A.D. 620 December 31.

"9th year of Emperor Temmu, A.D. 680, 11th month, 3rd day. There was a brightness in the east from the hour of the Dog to the hour of the Rat (*id est* 8 P.M. to midnight)."

Date A.D. 680 November 29. The hour of the Dog 戌 was from 7 P.M. to 9 P.M., and the hour of the Rat 子 from 11 P.M. to 1 A.M.*

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* The twelve signs of the Ju-ni-shi were used to designate the twelve Chinese hours of the day, each of which consists of 120 minutes.